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$$x+m_1y=x_1+m_1y_1, \quad x+m_2y=x_2+m_2y_2.$$

It is proposed to find the coördinates of the intersection of these lines when (x_1, y_1) approaches and becomes coincident with (x_2, y_2) . Eliminating x between the equations, we have

$$y=y_1+\frac{1+m_2\left(\frac{y_1-y_2}{x_1-x_2}\right)}{\frac{m_1-m_2}{x_1-x_2}}.$$

Since $\text{Lim.}_{x_1=x_2}\left(\frac{y_1-y_2}{x_1-x_2}\right)=\frac{dy_1}{dx_1}$ and $\text{Lim.}_{x_1=x_2}\left(\frac{m_1-m_2}{x_1-x_2}\right)=\frac{d^2y_1}{dx_1^2}$, we have

$$y=y_1+\frac{1+\left(\frac{dy_1}{dx_1}\right)^2}{\frac{d^2y}{dx^2}}, \quad \text{and} \quad x=x_1-\frac{dy_1}{dx_1}\left\{\frac{1+\left(\frac{dy_1}{dx_1}\right)^2}{\frac{d^2y_1}{dx_1^2}}\right\}.$$

105. Proposed by CHARLES C. CROSS, Meridithville, Va.

From all points in a straight line passing through the center of a given circle tangents are drawn to the circle. If the bases and vertices of all the angles thus formed are made to coincide; required the equation of the curve passing through the tangent points.

Solution by J. W. YOUNG, Oliver Graduate Scholar in Mathematics, Cornell University, Ithica, N. Y.

Let the circle be $x^2+y^2=a^2$, and the given line $y=0$. Then the length of the tangent from any point $(x_1, 0)$ on the given line is $\sqrt{(x_1^2-a^2)}$.

Also the slope of the tangent may be calculated from the equation $mx_1 \pm a\sqrt{(1+m^2)}=0$, which is obtained by substituting the point $(x_1, 0)$ in the tangent equation $y=mx \pm a\sqrt{(1+m^2)}$. Solving for m , we have

$$m^2=\frac{a^2}{x_1^2-a^2}, \quad \text{or} \quad m=\pm\frac{a}{\sqrt{(x_1^2-a^2)}}.$$

To determine the required locus, use polar coördinates, with the common vertex of angles as pole and their common base as initial line; the coördinates (r, θ) of the tangent points are then given by the equations

$$\left. \begin{aligned} r &= \sqrt{(x_1^2-a^2)} \\ \tan\theta &= \frac{\pm a}{\sqrt{(x_1^2-a^2)}} \end{aligned} \right\}$$

Hence, the required locus is $r\tan\theta=\pm a$; in Cartesian coördinates this becomes $x^2(y^2-a^2)+y^4=0$.

Also solved by H. C. WHITAKER, and G. B. M. ZERR.